

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE Y June 28, 1996		3. REPORT TYPE AND DATES COVERED final technical 5/1/95-12/31/95	
4. TITLE AND SUBTITLE Advances in Type Systems for Computing				5. FUNDING NUMBERS C: N00014-95-1-0999	
6. AUTHOR(S) John C. Mitchell					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Gates Computer Science Department - 4B Stanford University Stanford, CA 94305-9045				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) ONR 800 No. Quincy Arlington, VA 22217-5660				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release: distribution unlimited.					
13. ABSTRACT (Maximum 200 words) The <i>Advances in Type Systems for Computing (ATSC)</i> Euroconference was held at the Isaac Newton Institute in Cambridge from August 14 through 18, 1995. The main topic of the conference was the development and use of type systems for programming languages. The reason for interest in type systems is that types are the fundamental systems of "units" for computer programming, analogous to meters, joules and kilograms in physics. Type systems for programming languages make it possible to perform simple checks on computer programs and detect certain forms of errors before the programs are executed. Type systems are also an important part of software system design, particularly in design procedures that involve breaking a complex systems into separate parts. The ATCS conference program consisted of invited lectures, contributed papers, and on-the-spot contributions to impromptu sessions that were organized during the meeting. There were a total of 73 attendees, including 24 scientific visitors to the Newton Institute, 3 outside invited speakers, and 24 authors of contributed talks.					
14. SUBJECT TERMS DTIC QUALITY INSPECTED 4				15. NUMBER OF PAGES 2	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT unclassified	20. LIMITATION OF ABSTRACT unlimited		

19960705 099

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet optical scanning requirements.

Block 1. Agency Use Only (Leave blank).

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit Accession No.

Block 6. Author(s) Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. (If known)

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank.

NTIS - Leave blank.

Block 13. Abstract. Include a brief (Maximum 200 words) factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code (NTIS only).

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

Final Technical Report

Advances in Type Systems for Computing

ONR Travel Grant *Navy N00014-95-1-0999*

John C. Mitchell, PI

June 30, 1995

This grant funded travel of US participants in the *Advances in Type Systems for Computing* conference.

The *Advances in Type Systems for Computing (ATSC)* Euroconference was held at the Isaac Newton Institute in Cambridge from August 14 through 18, 1995. The main topic of the conference was the development and use of type systems for programming languages. The reason for interest in type systems is that types are the fundamental systems of “units” for computer programming, analogous to meters, joules and kilograms in physics. Type systems for programming languages make it possible to perform simple checks on computer programs and detect certain forms of errors before the programs are executed. Type systems are also an important part of software system design, particularly in design procedures that involve breaking a complex systems into separate parts.

The ATSC conference program consisted of invited lectures, contributed papers, and on-the-spot contributions to impromptu sessions that were organized during the meeting. There were a total of 73 attendees, including 24 scientific visitors to the Newton Institute, 3 outside invited speakers, and 24 authors of contributed talks.

The conference Call for Participation emphasized three related areas:

- extensions of the ML type system
- types in object-oriented programming
- type theories for reactive systems

The listed topics, and several others, were well-represented in the program. A surprisingly large fraction of the invited and contributed talks emphasized type systems for object-oriented programming. In fact, this active and

vibrant area accounted for 6 of 12 invited talks and 12 of 22 contributed talks. As a result, the conference had an unexpectedly sharp focus, leading to repeated discussion of type systems for object-oriented programming during coffee breaks and free time. Object-oriented type systems are a topical and important area since object-oriented languages provide one promising approach for improving in software productivity. Scientific progress on the underlying type systems of object oriented languages could significantly improve our understanding of software development, leading to improved programming languages and more effective program-development tools. In retrospect, it seems that the ATSC meeting was close to a watershed event for researchers and students in this particular subject area.

The format of the conference placed the primary invited and contributed talks between 9:30 AM and 2:30 PM. This left time for daily 3-5 PM special sessions, organized during the meeting by Newton Institute scientific visitors, at the invitation of the ATSC committee. This organizational strategy successfully attracted participation from scientific visitors then in residence and broadened the scope of the conference. With parallel sessions on Tuesday afternoon, and Wednesday left open for informal gatherings in the City of Cambridge, the four afternoon special sessions were:

- Object systems, chaired by L. Cardelli (DEC Systems Research Center), Newton Scientific Visitor and member of the ATSC organizing committee,
- Linear logic and games, chaired by Newton Scientific Visitor P. Scott (University of Ottawa),
- Constraint systems, chaired by ATSC invited speaker S. Smith (Johns Hopkins),
- Sign-up session or short talks by students and postdoctoral fellows, chaired by A. Gordon (University of Cambridge),
- Interim report on the ML2000 programming language project, chaired by R. Harper (CMU) and D. MacQueen (AT&T Bell Laboratories), both Newton Scientific Visitors.

The afternoon of short sign-up talks allowed students and post-doctoral-level participants to give short talks about current work.